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The Evaluation of Maximal Aerobic Capacity, a Prior Reference Point in Student Instruction

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Abstract

By knowing the correct values of the parameters of maximal effort corresponding to the stages in the energy consumption of an individual's body, we can externalize the coordinates of the dynamic effort, i.e. the nature of the instructional objectives, the role of the exercises, the volume of work involved and the intensity and complexity of the effort. The major energy systems have also been connected with physiological parameters such as: heart rate, blood pressure, respiratory rate, etc. The evaluation of the students' maximal aerobic capacity (VO_2max) is thus a prior reference point in the optimal management of effort parameters in institutional sports activities. During a set of systematic programs of physical exercises, the heart "learns" to work economically both at rest and during physical activities of various intensities. As a result, the heart rate decreases gradually and the heart gets better at adapting to effort.

This more or less guarantees heart disease prevention, optimizes cardiac input which involves the proper functioning of the cardiovascular system and of all the other organs of the human body. Besides inducing functional improvements, aerobic effort also develops muscle flexibility, joint mobility, coordination, it increases force, speed and resistance, thus improving the students' overall physical condition through its aerobic functional components.

Keywords: aerobic capacity, physiological parameters, didactic strategies;

1. Introduction

During the physical training and sports practical courses attended by the students at the Faculty of Psychology and Educational Sciences every week during 2 hours, we have scientifically evaluated their maximal aerobic capacity. The purpose of this initiative was to obtain objective results as a basis for establishing the content of these courses, as well as to make students realize how important and useful the regular practice of physical

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activities, sports and exercise can be. We have taken this initiative after having noticed the students' poor physical performance and their negative attitude towards sports and regular exercise.

For this purpose, tests were run on 10 students randomly selected by the specialized staff of the *Sports Counseling and Testing Center* in Constanta.

The data collected indicate that the students' physical condition is poor for their age, as a result of little exercise, limited physical effort and the beginnings of a sedentary lifestyle, which will sooner or later lead to health issues.

The test had a positive impact upon the students, and they showed interest in the results obtained and, more importantly, in their value and meaning. This paper contains an overview of the test results, as well as of some other previously devised programs.

1.1. Topicality of the theme

Aerobic effort is the light or moderate-intensity activity based on the oxidative (aerobic) energy system which is used in muscle contraction. On a physiological level, aerobic capacity represents the ability to:

- Take oxygen out of air
- Transport the oxygen from the lungs to the tissues
- Collect and use the oxygen at the level of the (effector) muscles (Dumitru, 1995).

According to Flandrois (1979) aerobic capacity, also called maximal aerobic capacity, is the maximal amount of available energy used in aerobic efforts, or the amount of mechanical work performed through aerobic energy generating reactions.

Maximum aerobic power (MAP) is, thus, the maximum power developed through a maximum heart rate aerobic metabolism, reached when the subject uses his/her maximal oxygen uptake (VO_2 max). In this case, training allows aerobic power to increase by up to 15-25%.

Maximal aerobic capacity is the maximal oxygen uptake percentage (VO_2 max) which allows the subject to base his/her effort only on the aerobic metabolism. Maximal aerobic capacity represents 50% VO_2 max in untrained subjects and 80% VO_2 max in trained subjects.

As effort capacity is best estimated by the oxygen uptake, aerobic power measures the maximal oxygen uptake (VO_2 max) in time units. Aerobic power is thus defined as oxygen volume consumed per minute in a maximal effort, and is expressed either in absolute values, i.e. ml O_2/min, or, even better, in relative values, i.e. ml O_2/kg body weight/min. Aerobic power is essential in endurance tests and activities. A large series of increased power efforts allow the measurement of oxygen uptake which increases by 1.4 l/min per 100W. At a certain point, although mechanical work continues to grow, the oxygen uptake becomes stable, which indicates that VO_2 max has reached its upper limit.

According to Flandrois (1982), maximum aerobic power is the minimum effort power which enables maximum oxygen uptake (VO_2 max). Stretches of activity longer than 3 minutes increase the importance of aerobic energy systems in energy production.

An increased aerobic power shown by exceptional VO_2 max values is essential for achieving high performance in endurance.

According to Daniels (1985), the energetic cost is used to express the necessary O_2 amount required in a certain intensity of effort. Different people use different O_2 amounts at the same intensity, which clearly illustrates the variation of effort energy consumption from one person to another. Thus, sportspeople with similar VO_2 max can have different resistance capacities due to the way they use their movements (technique).

Each individual's technique can be improved through resistance trainings and explained through biomechanical improvements of that particular activity or movement technique (Roberts R.A., Roberts S. 1997). Decisive factors in maximum aerobic capacity include heredity, age, environment, physical activity. The

literature seems to agree with the fact that the limit of aerobic performance capacity is greatly determined by heredity.

Astrand and Rodahl (1970) and Klissouras (1971) state that aerobic capacity improvement through training-instruction should not exceed 30-40% of the initial level. Higher percentages would be explained through increase at the initial level or/and the environment factors (Quirion, 1980).

Aerobic capacity favours training for both sexes, starting from childhood and adolescence. It increases between the ages of 10 and 20, even in untrained individuals, to gradually decrease with age after that. VO_2 max decreases in the same manner in untrained individuals, both in those with a higher and in those with a lower VO_2 max. It usually decreases by 8-10% after ten years. Training is important at any age, although its efficiency decreases with age. After 4-6 weeks of training, VO_2 max can substantially improve.

Physical maturity once reached, aerobic capacity can remain optimal even at an advanced age, around 50 (Kilbom, 1971). Physical condition in older people reduces to half, stimulating at the same time weight gain. Maximal aerobic capacity can be reduced by dividing the entire amount of oxygen to the number of kilos. VO_2 max /kg body weight/min can be increased through weight and fat loss.

Environmental factors (e.g.: high altitude) often limit aerobic capacity development. Decreased physical capacity at high altitude often occurs in endurance tests. In the first period, VO_2 max decreases, to start increasing after 3-4 adaptation weeks above the values obtained at a low altitude. The increase of effort capacity in the contemporary training system is based on hypoxic effort, as a way of adapting to average altitude.

The level of physical activity is one of the most important factors in the maintenance of aerobic capacity. A 3-week complete bed rest decreases aerobic capacity by 29%, which means about 10% per week. In order to recover the level prior to the rest, an individual needs an 8-week training program (Quirion, 1980).

VO_2 max indirect evaluation. Maximal or sub maximal exercise tests, each with its own advantages and disadvantages, allow the indirect VO_2 max acquirement by using the VO_2-effort power-CF connection. According to specialized literature, these tests are: the Astrand test, the Cooper test, the 6-minute test and the Yo-Yo test with its three versions.

2. Research description

The maximal aerobic capacity has been evaluated on 10 students in order to find their VO_2 max value. The results have been converted in the last phase into ratings which show the VO_2 max value for each individual according to a specific age. The students included in the research were aged between 19 and 28, more exactly: seven students were 19, two were 20 and one was 28. We have applied the Yo-Yo Endurance test - level 1. This test has been developed by Jens Bangsbo, one of the world's greatest physical coaches and an ex-football player for the Danish national football team.

Ten poles have been placed one in front of the other at a 20 m distance. The students were divided into two groups of five, with the test being applied in two series. During this test, each student was required to run forward and back for as long as possible on a specific distance previously mentioned. At a specific interval that started at 40-35 seconds and was then gradually reduced, a sound signal announced a new effort stage, which meant that the students had to run a little bit faster. The students continued to run in this manner until they reached a maximum speed effort stage they could keep for a longer period of time. Sound signals were recorded on a CD and transmitted through loudspeakers, extensively marking the intensive stages of effort. Students had to be careful so as to coordinate their effort and running speed with these signals.

Table 1. Students' results for the Yo-Yo Endurance Test Level 1 *Date*: 11.03. 2013 *Running surface*: Children's Palace – Constanţa

No.	Student's name	Age	Highest effort level reached	No. of 20-meter runs at the highest level	VO_2 max *(ml O_2/kg/min)*	Rating
1	R. Costina	19	7	2	34.0	Below average
2	N. Ioana	28	6	9	33.2	Below average
3	C. Teodora	19	6	1	30.3	Poor
4	M. Claudia	20	6	2	30.5	Poor
5	V. Madalina	19	6	1	30.3	Poor
6	P. Liliana	19	8	6	39.1	Average
7.	S. Laura	19	5	8	29.6	Poor
8.	O. Marinela	20	6	2	30.4	Poor
9.	C.Elena	19	8	6	38.3	Average
10.	D. Anca	19	7	2	34.2	Below average

Table 2. Maximal oxygen uptake norms for women (ml/kg/min; Fitness test, 2013)

	Age (years)					
Rating	18-25	26-35	36-45	46-55	56-65	65+
Excellent	> 56	> 52	> 45	> 40	> 37	> 32
Good	47-56	45-52	38-45	34-40	32-37	28-32
Above average	42-46	39-44	34-37	31-33	28-31	25-27
Average	38-41	35-38	31-33	28-30	25-27	22-24
Below average	33-37	31-34	27-30	25-27	22-24	19-21

3. Analysis of the results

The chart above contains important information regarding test application, the highest effort level and the number of runs at that particular effort level. The maximal Ox uptake for each individual is given in *mlO_2/kg/min.* This value is converted into ratings, as in the chart below - according to age and rating features.

Table 3. The results reported in the three grades

Rating	No. of ratings	Highest effort level reached	No. of runs at the highest effort level	Values for mlO_2/kg/min
Average	2	8	6	39.1; 38.3
Below average	3	6 and 7	2 and 9	34.0 ; 33.2 ; 34.2
Poor	5	5 and 6	1,2 and 8	30.3 ; 30.5 ; 30.3; 29.6 ; 30.4

Interpretation of the results. 50% of the ratings are poor, with values ranging between 29.6 and 30.5 $mlO_2/kg/min$, with 6 and 5 respectively as the highest effort levels and a number of runs between 1 and 8.

Below average ratings account for 30% of the results, with O_2 max uptake values between 33.2 and 34.2 $mlO_2/kg/min$, the highest effort levels being 2 and 9 respectively.

The average rating is the best rating students have obtained, and they account for 20% of the results, with values of 39.1 and 38.3 ml $O_2/kg/min$, at an 8-effort level with 6 repetitions in both cases.

4. Conclusions

In conclusion, we can say that the best test result, meaning the highest O_2 max uptake, VO_2 max, is 39.1 $mlO_2/kg/min$, and the lowest is 29.6 $mlO_2/kg/min$, the highest effort level is 8 and the highest number or runs is 9. The lowest effort level is 5 and the lowest number of runs is 1.

Half of the students obtained a poor rating, while the other half scored average or below average. Consequently we can state that the students surveyed do not have a good maximal aerobic capacity; it is at most satisfactory or even unsatisfactory.

We can see that from the ratings above, which do not include any good rating, the maximal value being average. The Yo-Yo test is significant for the evaluation of the students' aerobic capacity, it is easily carried out and interpreted, on condition that specialized devices are available. Students are generally interested in taking tests such as the one described above.

In our future activities, we aim to develop a set of programs meant to improve the students' aerobic capacity, as long as they approach them with some interest and enjoyment.

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